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This group of photographs was taken at the Soil Erosion Experiment Station near Tjiwidej, Residency of Priangan, West Java.

Fig. 42 (upper left)—Unterraced slope under cultivation.

Fig. 43 (upper right)—Terraced slope under cultivation.

Fig. 44 (lower left)—View of the catch basins.

Fig. 45 (lower right)—Closer view of the upper catch basin shown in Fig. 44.

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gated fields. One of the great advantages of garden culture over field culture is that there is always something ready to harvest from the former and therefore something to sell when money for daily household needs becomes scarce. Another advantage is that the garden supplies the family with a great variety of side dishes rich in vitamins; the vegetable proteins of the garden produce are also of high value.

As to the possibilities of improving garden culture, these two authors state:

> It is very evident that an improvement of the compound horticulture is a very difficult problem through the highly varied and dense planting of these compounds as a result of which they come to resemble a very complicated symbiosis. But for all this it must be possible by systematic investigation to improve not only the quality but also the quantity of the production. It may be said that the compounds with their story or layer formation superficially considered will find no favour in the eyes of western agriculture, but they are an essential link in the native production apparatus.[3]

The alarming decline in the welfare of the people of Java in the face of a mounting population prompted Netherlands Indies officials to examine every possibility of improving the peasants' condition. This accounts for the studies of Ochse and Terra. Lacking detailed studies outside Java, we are obliged to depend upon scattered references of uneven value.

Credner states that in Thailand practically every house has a few trees on the lot, and the villages are often hidden by tree clusters. The greatest intensification of garden culture is found on the right bank of the Mae Nam Chao Phraya (the Menam) in Bangkok Noi, just opposite Bangkok. Here irrigation is employed in garden culture, a technique not usually found in Southeastern Asia. The gardens are surrounded by walls 1 meter high and are traversed by trenches 2 meters apart. The beds between the trenches are elevated. The trenches work both as drains and as irrigation ditches. Small sluices control the water. In the gardens there is a great variety of fruit trees and palms which climbers, such as *Piper betle* L., use as supports. In the trenches the peasants grow lotus and water chestnut (*Trapa natans* L.).[4] Zimmerman, in his survey of rural Thailand, points out that in most regions the peasants rely too much on one crop, rice, and he recommends in several instances improvements in the cultivation of the home lots so that families may have a better supply of fruits and, above all, of vegetables. In the Khlong Rangsit section he observed that "on account of the lack of homestead and village sites among the people there is no gardening and home production of food."[5] This observation may be applied to Southeastern Asia in general. Wherever the dominant form of land tenure is tenancy the flimsy shack of the tenant has no mixed fruit and vegetable garden around it, for his status is much too uncertain. A tenant

[3] Ochse and Terra: *op. cit.*, pp. 371–372.
[4] Credner: Siam, 1935, p. 246.
[5] Zimmerman: Siam, 1931, p. 307.

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lanzones, papayas, and chicos, which find a good market in Manila, but on the whole we rarely meet in the Philippines such intensive garden culture as in Java. The diet of the average Filipino is not well balanced and is particularly deficient in fruits and vegetables. In recognition of this fact the Bureau of Education and the Bureau of Plant Industry have both done much to impress the peasants with the need for fruit and vegetable gardens. Although the situation has improved during the past forty years and a large variety of fruits is now produced, the country still depends upon imports, whereas with a little effort most of the imported fruits could be produced locally and would furnish an additional source of income. It would be well to encourage the peasants to grow more fruits and to advise them on the most suitable varieties. In the other countries of Southeastern Asia, also, with the possible exception of Java, such advice would be valuable.

The published material available on the importance of gardens in Indochina is similarly limited in quantity. Even Gourou in his study of land utilization restricts himself chiefly to listing the fruits and vegetables found in the gardens and to stating that certain districts are renowned for the quality of their garden fruits. Gourou's list of fruits and vegetables is as varied and extensive, however, as similar lists for any of the other countries of Southeastern Asia.

Wet Fields

Throughout the countries bordering the South China Sea most of the cultivated land is used for the growing of lowland, or wet, rice. For this purpose the fields must be leveled and surrounded by earth dams to impound rain water during the rainy season or to confine the water that is carried to the fields through irrigation canals or lifted to the fields by mechanical means. If a field is properly leveled the surrounding dyke will keep the water everywhere at the same depth. The size of the wet-rice, or paddy, fields, and the amount of labor that is required to make them, depend upon the topography of the region. In the lowlands, where no terracing is required, there is relatively little labor involved in the making of paddies, which are frequently large. A hilly, or mountainous, terrain necessitates terracing, which demands greater effort and reduces the size of individual fields; the steeper the slope, the narrower the paddies. We have only to see the rice terraces of the mountains of northern Luzon, southern Bali, the Preanger districts of West Java, or Sumatra's West Coast in order to realize how much effort has been expended in building these terraces and how much energy must be devoted to their upkeep. The terraces, as well as the wet-rice fields of the plains, represent the accumulated efforts of generations of peasants, each of which has helped to extend the area devoted to the cultivation of wet rice (Figs. 50–58).[1]

Not all people show the same skill in the making of paddies. According to Credner, the Thai are quite helpless on sloping land that requires terracing before wet rice may be planted. They would prefer to migrate to a

[1] [See pp. 115 ff. category 116. -- Analyst]

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region where level land is available rather than undertake the terracing of a hillside; on the other hand, they have been successful in building innumerable canals to tap rivers and spread the water over the plains.[9] However, they do not seem to be able to fight great floods. In contrast, the Annamese of Tongking have built huge dykes against destructive floods and the attack of the sea.

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The problems presented by the cultivation of wet, or lowland, rice change from country to country, from region to region, and sometimes even from village to village. Lowland rice demands a soil thoroughly soaked with water and worked into "a fine soft mud by hoeing, plowing, trampling, or harrowing, and . . . free from weeds." [10] The field must remain under water until the ears of rice begin to fill and harvest time approaches. The amount of water required to grow lowland rice depends upon the variety of rice, the length of its growing period, and the nature of the soil. There are innumerable varieties of lowland rice. One way of grouping them is according to the number of days they take to mature, which ranges from 60 to 300 days. In the Philippines varieties that require less than 150 days are considered early maturing, those that need from 150 to 190 days medium-late maturing, and those needing more than 190 days late maturing.[11] The longer the growing period, the greater the water requirements and, generally, the higher the yields. Normally the water covering the field has a depth of from 10 to 15 centimeters. But "floating rice" can keep pace with a slowly rising flood and reach the amazing height of 4 meters or more. The stems settle on the mud when the water recedes, and new roots start at the upper nodes, while the lower parts of the stems rot away. Floating rice is especially well known in Cochinchina, and I have seen it in the Philippines. In 1939 the Department of Economic Affairs in Batavia sent a rice expert to Cochinchina to study floating rice and the possibility of introducing it into southern Borneo.

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Lowland rice can be grown on many types of soil as long as a heavy clay subsoil is present to prevent the loss of water through percolation. Copeland states that lowland rice does best in heavy soils that hold water securely, and he adds that it is desirable "that there be, at a depth below the reach of the roots, but not too much further down, an impervious substratum-subsoil or hard-pan." [12] We distinguish between two main types of wet-rice fields: those that depend exclusively upon the rain that is impounded by their dykes, and those that are supplied by an irrigation system and are therefore no longer subject to the irregularities of rainfall.[13]

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[9] Credner: Siam, 1935, pp. 203 and 217.

[10] Wickizer: "Rice and Wheat," 1941, p. 272.

[11] University of the Philippines: Handbook of Philippine Agriculture, 1939, pp. 7–11.

[12] Copeland: Rice, 1924, p. 45.

[13] An important variation of the second type is the cultivation of wet riceland that has been flooded by rivers rising above their natural levels. This mode of cultivation, which is found especially in the residency of Palembang in Sumatra, in southeastern Borneo, in Thailand, and in Indochina, is not so dependable as irrigation because of the irregularities of the river floods.

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Irrigation systems also fall into two categories: peasant irrigation works and technical irrigation works. The former have existed throughout Southeastern Asia for more than a thousand years. In recent times scientifically trained engineers have designed large-scale systems with concrete weirs and locks. Fields solely dependent upon impounded rain water produce one rice crop a year, whereas irrigated fields often yield two crops. If even with irrigation only one crop can be produced, yet the irrigation system assures proper water control, whereas without it irregularities in the course of the rainy season may damage, or destroy, the crop.

Wet fields are protected against erosion by leveling, terracing, and dyking. But how does continued cropping affect the fertility of wet-rice fields? Diverse environments and cultural practices in Southeastern Asia create considerable differences in this respect. Much of the paddy land of the Philippines, Indochina, Thailand, Malaya, and Burma has lost a good deal of its original fertility because the peasants have not used manures, fertilizers, or crop rotation. In many instances, however, soil fertility has been preserved by the mineral matter dissolved in the irrigation water and by the silt deposited on those fields that are supplied with irrigation water coming from streams. The value of the water and silt depends, of course, upon the nature of the parent material from which it is derived. Rivers from a young volcanic region supply much richer water and silt than do those that drain a mountain region consisting of sedimentary rock or granite. For this reason, the Irrigation Service of the Netherlands Indies before making final plans for a new irrigation system takes samples of water and silt carried by rivers at different times of the year. The samples are analyzed in order to determine their influence upon the soil to be irrigated. A river found to be carrying water and silt that would lower the value of paddy land would be eliminated as a source of irrigation water, or its use would be limited as much as possible.

Irrigated fields of which the water supply does not contain minerals in quantities necessary for continuous satisfactory plant growth and paddy land that depends exclusively upon rain, both require other techniques for maintaining fertility. In many regions cultivators cut the rice stems just far enough below the ear to allow bundling. This practice makes possible the return of the rest of the plant matter to the soil. From this it is only one more step to work household refuse into the ground together with ashes of burned rubbish, rice husks, leaves, and manure.

As stable manure is not available in adequate quantities, intensive studies of the application of green manures to the cultivation of rice have been made in a number of countries of Southeastern Asia. A recent article by W. Bally reviews the results of these studies.[14] In a few rice-growing regions the peasants, on their own initiative, have learned to use legumes to improve rice soil. In wet fields the decomposition of green manure takes place under anaerobic conditions, and the final product is ammonia. Since

[14] Bally: "The Employment of Green Manures," 1936, pp. T10–T31.

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with sugar or tobacco grown under plantation management. But is the high fertility of the soil due to this crop rotation, or is it rather the result of the heavy application of commerical fertilizer and the thorough cultivation of the soil under Western management?

In no country of Southeastern Asia is there so great a variety or so intensive a use of commercial fertilizers as in Japan.[17] In general, the peasants of Southeastern Asia lack money for commercial fertilizers. In Indochina local phosphates are within reach of some of the Annamese, but the costs of imported fertilizers are prohibitive. In Java, although attempts to make possible the use of fertilizers through the agency of public credit institutions were successful in some special instances, not more than one per cent of the cultivated area received any commercial fertilizer in 1939. On the other hand, estimates indicate that more than 1,000,000 hectares of sawah have a phosphate deficiency and that a moderate application of phosphate would augment the yield by 25 to 50 per cent.[18]

The Agricultural Advisory Service was able to raise the productivity of wet-rice fields in West Java by about 10 per cent. It encouraged the peasants to use fertilizer on seedbeds, to sow rice more thinly on the beds (thus producing stronger seedlings), and to plant the seedlings in rows so that weeding could be done with a special instrument, the *landak* (Fig. 59).[1] This weeder was developed in Japan. During the years immediately preceding 1939, these improvements in West Java resulted in an increase in output of unhusked rice amounting to 300,000 quintals, or 30,000 metric tons, with a value of nearly 1,000,000 guilders. This shows that some improvements in cultivation may increase production without a great capital outlay.[19]

Java may be compared only with southern China and with Japan in the cleanness of its rice fields. The Filipino does not pay much attention to weeding. The Malayan, Thai, Cambodian, Cochinchinese, and Filipino rice farmers have more flooded riceland per capita at their disposal than the people of Java and can thus afford to cultivate their land less intensively.

Irrigation Problems

Peasant irrigation works usually take care of the fields of only one village or of a small group of people who have joined together for the specific purpose of building and maintaining an irrigation system. These works consequently are small and usually inadequate, but nevertheless they de-

[17] "The chief commercial fertilizers used in Japan are pressed herrings, pressed sardines, dried sardines, other fish cakes, bone meal, soybean cake, rapeseed cake, cottonseed cake, other vegetable-oil cakes, ammonium sulphate, calcium cyanamide, calcium phosphate, and potassium phosphate. Calcium phosphate and ammonium sulphate are probably the most representative chemical fertilizers."—Wickizer and Bennett: The Rice Economy, 1941, p. 252, footnote 33.

[18] Departement van Economische Zaken: Voedselproblemen, 1940, p. 28.

[19] *Ibid.*, pp. 27–28.

1 [See p. 117, category 116. -- Analyst]

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mand respect and admiration for the ingenuity displayed.[20] "The serious imperfections which characterize native irrigation works and make rice culture uncertain, particularly in the plains, can assuredly not be charged to the account of these who constructed them." [21] The weirs, by means of which the peasants raise the water of small rivers, are especially weak. The construction material consists of bamboo, trunks of coconut and other trees, and boulders. At times great bamboo baskets are filled with heavy stones and placed in the river, or large stones are laid loosely across the channel. Where the rivers are wide the people drive two rows of tree trunks into the river bed and fill the space between the rows with whatever debris they have at hand. These weirs frequently break because of river floods as they have no provision for allowing passage of flood waters; yet repair is often impossible for the duration of the rainy season, so that the crop is ruined. Another constructional disadvantage is the open intakes. During floods large quantities of water flow through these and cause an excessive soaking of the fields and damage to the canals. Wherever a canal has to cross a depression, a road, or another watercourse, bamboo or hollowed tree trunks are used to carry the water overhead. This often leads to large losses of water, especially during floods. Poor drainage is another weakness of peasant irrigation systems.

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Scientifically trained engineers have come to the aid of peasant communities in Southeastern Asia and have designed irrigation systems based on technological principles and free from the weaknesses of peasant irrigation works. One of these technical irrigation systems may take care of tens of thousands of hectares of riceland belonging to hundreds of villages. In many instances the engineers have improved existing peasant irrigation works; more often they have made irrigation possible where peasant communities did not have the financial and technical resources to overcome natural obstacles. Technical irrigation works are usually government-financed.

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In the Philippines most of the wet-rice fields are dependent exclusively upon the rain that falls directly on them. One centimeter of rain a day is said to be necessary for a healthy rice growth. But there is always the possibility that, particularly in the months of May and June, there may be so little rain that the peasants cannot prepare their fields. A shortage of rain in October is also dangerous as it may seriously damage, or even destroy, the crop, even though the precipitation during the rainy season may have been enough for the production of a satisfactory crop. To guard against an insufficiency of water for the wet-rice crop, therefore, the fields should be supplied by irrigation systems. The Philippines, however, do

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[20] The *subaks* of Bali are agricultural cooperative societies that have been formed to construct, maintain, and administer irrigation systems. The achievements of the Balinese subaks are very remarkable in a number of ways. Thus, the men of certain villages are especially skillful builders of irrigation works and are able to construct long canals and even tunnels of considerable length. These men are hired by the subaks and help them to solve their irrigation problems.

[21] Van der Meulen: "Irrigation in the Netherlands Indies," 1940, p. 146.

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of contemporary relief forms and drainage patterns. The rate of coastal advance seaward upon the Platform is in places phenomenally rapid; the Tjimanoek (Fig. 19) and Solo deltas in Java are extending at the rate of 100 metres annually, the Mekong at 60–80 metres annually. An outburst of volcanic ash increases the deposition by neighbouring rivers at the coast, though the behaviour of sea currents moulds the riberine deposit in detail on reaching the sea. Mangroves and associated vegetation quickly establish themselves on sandbanks and cays so that at the mouth of the Perak, for example, an exposure of a bank for only a few days at a low water season is enough to permit vegetation to start there, hastening the rate of deposition by offering an obstruction to river outflow and thereby perpetuating the bank which in other settings might disappear by erosion during the next high water spell.

Where streams debouch into deep seas the rate of coastal extension is inevitably less, due to the greater thicknesses which must be laid for every outward extension, yet the Irrawaddy Delta is building outward at the rate of about 60 metres per annum; that the Irrawaddy can maintain this rate of building into a deep basin reflects its tremendous load and a physical condition which concentrates the deposition of this load at the outer edge of the Delta rather than over its surface. (See Chapter 9.)

Because the rivers are steadily sedimenting the bed of their lower reaches, these are in fact generally being raised in level. Such a process cannot continue very far; when its bed is raised slightly above the surrounding land, the river easily changes course, and every large delta of Southeast Asia shows signs of frequent migration of distributaries. Old channels and distributaries in various phases of abandonment may be seen at nearly every river mouth. Most deltas suffer regular inundation at various times of the year facilitating farming for rice, which depends on either natural or artificially induced floods, in most cases derived from rivers. The process of spreading sediment over the whole delta zone goes on both by migration of distributaries and by seasonal inundations, so that the deltaic surface over a wide area is being slowly raised by sedimentation, making it progressively more difficult to irrigate the inner and higher sections of the deltas and in the long run causing the centre of gravity of irrigation steadily to move

tial area is primarily on higher ground in the northern part of the city. The University of Malaya is located in Singapore, though plans are being made to move it to Johore Baru on the Malayan mainland. Being largely a Chinese city, Singapore has come to act as a center for the Nan Yang expatriate Chinese, and the city has been chosen as the site of a new Chinese-language regional university.[20] Nevertheless, its air is not that of a Chinese city, nor, for that matter, is it English. Like all great cities, it is cosmopolitan, but it is also culturally rootless, perhaps more so than any of the other great cities of the region.

At the other extreme is Bangkok, most indigenous of the great cities. Founded as the last of a series of "forward capitals"[21] by the Thai in 1783, after the destruction of Ayuthia by the Burmese, the city has never lost its native quality. The soaring rooftrees of *bot* and the spires of stupa stamp the Bangkok skyline with a character of its own. The city is located on the left bank of the Menam Chao Phya within the southernmost great bend of the river some twenty miles from its mouth. Exceptional problems of poor drainage plagued the city from the start, and its numerous *klongs* or canals have given it the rather misleading title of the "Venice of the East."

A Chinese city early appeared to the southeast of the original castle town and in time became part of the central business district. As the lesser *klongs* were filled in to become roads, the city continued to expand. A new city appeared on the northern outskirts of the old, a planned creation built in the reign of Rama VI with broad boulevards and buildings ranging from shocking Victorian variations on Italian Renaissance to more recent battleship modern. The contrast between the façade of modern buildings fronting these boulevards and the stilted, bamboo, thatch, and tin-roofed houses

[20] Richard Butwell, "A Chinese University for Malaya," *Pacific Affairs*, December, 1953.

[21] See reference to Cornish in Spate, *op. cit.*, p. 624.